Review of the Acid Deposition Management Framework and Its Implementation

Alberta Environment

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by

Acid Deposition Assessment Group

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FOREWORD

Alberta Environment adopted the Acid Deposition Management Framework developed by the Clean Air Strategic Alliance for management of acid deposition effects in Alberta. The framework was described in the report: *Application of Critical, Target, and Monitoring Loads for Evaluation and Management of Acid Deposition (AENV, 1999).* The framework prescribes a 5-year assessment cycle involving:

- Assessment of potential acid input (PAI) in each 1° latitude by 1° longitude grid cell in Alberta using the REgional Lagrangian Acid Deposition (RELAD) model.
- Evaluation of RELAD model-based PAI estimates using monitoring data.
- Revision of receptor sensitivity, as appropriate, based on new data.
- Comparison of PAI to receptor sensitivity. Management actions for acidifying emissions are required if monitoring, target, or critical loads are exceeded.
- Review, and possible revision, of the framework.

The Acid Deposition Assessment Group (ADAG) was appointed by Alberta Environment to guide the assessment and review the framework. ADAG consists of representatives from government, industry, and environmental organizations. Three documents were produced:

- an acid deposition assessment report
- a framework review report, and
- an acid deposition management framework document.

This document is the framework review report that summarizes conclusions and recommendations arising from the review by the ADAG of the 2004 acid deposition assessment and of the 1999 framework.

Lawrence Cheng
Chair, Acid Deposition Assessment Group
Environmental Policy Branch

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1.0 INTRODUCTION

The Acid Deposition Assessment Group (ADAG) was appointed by Alberta Environment (AENV) in 2002 to function as an advisory body to the implementation and review of the Acid Deposition Management Framework: *Application of Critical, Target, and Monitoring Loads for the Evaluation and Management of Acid Deposition* (AENV, 1999). This framework was developed by the Clean Air Strategic Alliance (CASA) and adopted by Alberta Environment in 1999 for the management of acid deposition effects in Alberta. The framework, referenced as 'the 1999 framework' in this document, prescribes a 5-year assessment cycle involving:

- Assessment of acid deposition, which entails:
  - Assessment of potential acid input (PAI) in each 1° latitude by 1° longitude grid cell in Alberta using the REgional Lagrangian Acid Deposition (RELAD) model. The initial assessment under the 1999 framework was completed in 1999 with a second assessment scheduled for approximately 2004.
  - Evaluation of RELAD model-based PAI estimates using monitoring data.
  - Revision of receptor sensitivity, as appropriate, based on new data.
  - Comparison of PAI to receptor sensitivity. Management actions for acidifying emissions are required if monitoring, target, or critical loads are exceeded.
  - Review, and possible revision, of the framework.

The ADAG consists of representatives from government, industry, and environmental organizations (Appendix 1).

This document summarizes conclusions and recommendations arising from the review by the ADAG of the 2004 acid deposition assessment and of the 1999 framework.

2.0 2004 ACID DEPOSITION ASSESSMENT

The ADAG has reviewed the 2004 acid deposition assessment and provides the following conclusions:

- *Potential Acid Input in 2004*: The results of the acid deposition assessment are reported in detail in the report "2004 Acid Deposition Assessment for Alberta", prepared for ADAG by WBK and Associates (2007a). The following are the key results of the assessment:

  - The year 1980 is a representative meteorological year for modeling purposes. The selection of 1980 was based on examination of RELAD model estimates for each of the years 1971 to 2000 using 1995 emission data and meteorological data for each of the years 1971-2000.

  - Sulphur emissions declined from 1995 to 2000 and are predicted to rise from 2000 to 2010, but not up to the 1995 level.

  - Nitrogen emissions increased from 1995 to 2000 and a further increase is predicted by 2010.

  - RELAD model-based deposition estimates were determined with 1980 meteorology and 1995 and 2000 emission inventories and 2010 emission projections. There were increases and decreases over time in PAI in individual grid cells, but no clear or consistent trend. PAI did not exceed monitoring, target, or critical levels in any grid cell for any of these three emission scenarios.

- *Model Evaluation*: Potential Acid Input estimated from wet deposition measurements and air quality data was in general agreement with RELAD model-based results. However, the evaluation of model results was not as clear-cut as ADAG had hoped it would be, possibly due to the following:

  a. Emissions may vary substantially from year to year. The emission inventory used for modeling may differ from actual emissions during each of the years for which monitoring results were compared to model estimates.

  b. Meteorology varies from year to year so the 1980 meteorology may differ from the actual meteorology in each of the years for which monitoring results were compared to model estimates.

  c. RELAD estimates are for average PAI over a grid cell, while monitoring stations measure site specific air quality, which may differ from the grid cell average, depending on proximity of the monitoring station to significant emission sources.

- *Receptor Sensitivity:*

  a. A number of studies to advance understanding of soil sensitivity were conducted during the 1999-2004 assessment cycle, largely in the oil sands region. These studies do not yet provide a basis for altering the sensitivity ratings currently assigned to grid cells.

  b. A number of studies to advance understanding of lake sensitivity were conducted during the 1999-2004 assessment cycle, largely in the oil sands region. These studies suggest that subsoil sensitivity may not be a reliable surrogate for lake sensitivity. However, these studies do not yet provide a basis for altering the sensitivity currently assigned to grid cells.

  c. The acid deposition sensitivity of the Provost-Esther grid cell was reassessed, after finding in the 1999 acid deposition assessment that PAI was 0.18 keq H^+/ha/yr, which was in excess of the monitoring load of 0.17 keq H^+/ha/yr assigned to that cell. This grid cell and an adjacent grid cell were reclassified from highly to moderately sensitive, based on analysis and interpretation of soil samples in the grid cell (AENV, 2001).

- *Potential Acid Input in Relation to Management Thresholds:* using emission inventories for 1995 and 2000, or emission projections for 2010, PAI does not exceed the critical load, the target load, or the monitoring load in any grid cell. Consequently, acid deposition does not exceed any of the thresholds requiring management actions under the 1999 framework.

3.0 REVIEW OF THE 1999 MANAGEMENT FRAMEWORK

The ADAG has reviewed the 1999 management framework and provides the following conclusions:

- The 1999 framework was the first framework for the management of sulphur and/or nitrogen emissions in Alberta, aside from air quality standards. Since then other provincial and/or national management frameworks with implications for the management of sulphur and/or nitrogen emissions have been adopted (Appendix 2). One or more of these frameworks may potentially result in enhanced emission management actions even though the 1999 framework does not.

- The 1999 framework continues to provide a good basis for managing acid deposition on a provincial scale and no substantive changes are recommended.

- Enhancements to management of acid deposition on a local scale:

  A key principle is that acid deposition on a local scale should be managed to provide a level of protection equivalent or better to that of the provincial framework. A key feature of local assessment of acid deposition is the use of a local/regional scale model (currently CALPUFF). This model provides a sufficient spatial resolution of deposition in the vicinity of large point sources or multiple closely spaced sources. It can also help to manage emissions and protect resources that may not be adequately protected by a 95% level of protection on a 1° latitude x 1° longitude grid cell. The ADAG has developed a new framework document (AENV, 2007b) that summarizes the 1999 approach to provincial assessment and includes recommended enhancements to the approach for local assessment.

- Consideration of a strategy to enhance the provincial receptor sensit[illegible]y database:

  a. Soils: The 1999 framework defines three categories of sensitivity (low, medium, and high), based on soil properties in the vegetation rooting zone. Numeric monitoring, target, and critical loads were assigned to each of these three categories based on a review of studies in other jurisdictions. This continues to be the best approach with the soil data that is available on a provincial scale. The strategy should consider enhancing the soil database to support consideration of alternative approaches for setting grid-cell specific monitoring, target, and critical loads. The simple mass balance model has been widely used in Europe and eastern Canada for this purpose and dynamic models are being considered in Europe and being developed in the oil sands region.

  b. Lakes: The strategy should also consider enhancing the lake sensitivity database to support consideration of alternative approaches for determination of lake-specific critical loads based on watershed characteristics. Various steady state and dynamic models are available for this purpose.

- Review of the treatment of nitrogen in the framework:

  The approach adopted in the 1999 framework treats all deposited nitrogen as acidifying. This may over-estimate the acidifying effect of deposited nitrogen. Since target loads are not currently exceeded on any grid cell in Alberta, there has not been an urgent need to date to revise this approach. However, this may change with increasing population growth and industrial development in the province. The Cumulative Environmental Management Association (CEMA) has recommended, and AENV has accepted, an interim approach for environmental impact assessments in the oil sands region. Under this approach, any nitrogen deposition in excess of 10 kg/ha/yr, and 25% of the first 10 kg/ha/yr of deposited nitrogen, will be considered acidifying. A CASA nitrogen project team may be a suitable body to conduct a review of nitrogen related issues including acidification and eutrophication.

- The RELAD model is the model selected for estimating acid deposition in the Acid Deposition Management Framework. Our understanding of atmospheric chemistry, dispersion processes, and deposition mechanisms has improved but the RELAD model has not been upgraded to reflect our improved knowledge. There is a need to review deposition models to determine whether RELAD remains the most appropriate model to use or if it requires updating.

- The current assessment is for the five-year cycle period ending in 2004. Although the process was initiated in 2001, it took approximately five years to complete. The main reasons for the length of the review process were: the delayed release of the 2000 emission data, and the lack allocation of sufficient resources from Alberta Environment. Another minor reason was the time required for developing a framework for regional applications. Securing resources from Alberta Environment will be key for the success of future assessments. The common pollutant inventory is now being prepared under the National Pollutant Release Inventory Program, and it is anticipated that the turnaround time for emissions inventory release will be much quicker. Furthermore, if the tasks of the assessment are confined to the five components specified in the Framework document, the assessment should be conducted at a much faster pace.

4.0 RECOMMENDATIONS

To facilitate the next PAI assessment and review of the Management Framework, it is recommended that:

a. AENV initiate the next assessment and review in 2009 and complete by 2011.

b. AENV commit adequate manpower and financial resources to complete the assessment and the review in a timely manner.

c. AENV and Airshed Zones enhance the monitoring network for future model comparison. This could include additional wet deposition (currently 8 precipitation quality stations), additional air quality monitoring stations, and enhanced accessibility to data from stations operated by Airshed Zones. There is also a need to establish operational dry deposition monitoring in Alberta.

d. AENV broaden the involvement of experts in the science of acid deposition.

e. AENV consider the 2005-2009 acid deposition research program conducted by CEMA in the oil sands region and if appropriate include its results in the next assessment.

f. AENV review the RELAD model prior to the start of the next assessment (December 2008).

g. AENV utilize a multi-stakeholder group to review the approach for assessing sensitivity, and develop a strategy or a long-term program to build a better database for receptor sensitivity to support the approach

h. As part of the next assessment AENV utilize a multi-stakeholder group to review the treatment of nitrogen in the Framework.

5.0 REFERENCES

Alberta Environment (AENV). 1999. *Application of Critical, Target, and Monitoring Loads for the Evaluation and Management of Acid Deposition.* Alberta Environment Publication No. T/472. Environmental Service, Environmental Sciences Division, Edmonton, AB. November 1999.

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Alberta Environment (AENV) 2007a: *2004 Acid Deposition Assessment for Alberta.* Report prepared by WBK & Associates Inc. Alberta Environment, Edmonton, AB.

Alberta Environment (AENV) 2007b: *Alberta Acid Deposition Management Framework.* Alberta Environment, Edmonton, AB.

APPENDIX 1 MEMBERS OF ALBERTA ENVIRONMENT ACID DEPOSITION ASSESSMENT GROUP.

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APPENDIX 2 PROVINCIAL AND NATIONAL FRAMEWORKS WITH IMPLICATIONS FOR MANAGING SULPHUR AND NITROGEN EMISSIONS.

Table 1. Description of Provincial and National Management Frameworks that have implications for management of S and N emissions in Alberta

Framework	Document	Jurisdiction and Date Issued	Goal	Pollutants/ Emissions Managed	Implementation Agency	Compliance Assessment	Management Actions if Non-Compliance
Canada-Wide Acid Rain Strategy for Post 2000	The Canada-Wide Acid Rain Strategy for Post-2000: Strategy and Supporting Document http://www.ccme.ca/assets/pdf/1998_acid_rain_strategy_e.pdf	Federal/ Provincial/ Territorial governments 1998	To meet the environmental threshold of critical loads for acid deposition across Canada and keeping the clean air clear in areas that are below the critical loads	Precursors of acid deposition (SO_2 and NO_x) SO_2 emission reduction in eastern Canada	Federal, Provincial and Territorial governments	Annual progress report on emissions and forecasts, compliance with international commitments on SO_2 and NO_x emissions, and progress in implementing the Strategy	N/A
Alberta's Approach to Pollution Prevention and Conservation	http://www3.gov.ab.ca/env/waste/pprevention/index.html	Alberta 2002	Promotes continuous improvement through operational and behavioural changes.	Waste from small and medium-sized enterprises	Small and medium-sized enterprises	N/A	N/A
Provincial PM & Ozone Management Framework	Guidance Document for the Management of Fine Particulate Matter and Ozone in Alberta	Alberta 2003	Minimize risk to human health and the environment, balancing the desire to achieve the best health and environmental protection possible in the relative near term and the	Ambient $PM_{2.5}$ and ozone $PM_{2.5}$ management action thresholds are 15, 20, and 30 $\mu g/m^3$ CWS metric Ozone management action thresholds are 58 and 65 ppb, CWS metric[2], with a	AENV, supported by EC, airshed zones, contributing emitters	Monitoring of ambient ozone and $PM_{2.5}$	AENV and/or affected airsheds - develop a plan within 2 years to reduce, or prevent further increase in ozone, or - implement surveillance of the emissions causing non-compliance

Framework	Document	Jurisdiction and Date Issued	Goal	Pollutants/ Emissions Managed	Implementation Agency	Compliance Assessment	Management Actions if Non-Compliance
			feasibility and costs of reducing the pollutant emissions that contribute to elevated PM and ozone	surveillance threshold at the discretion of AENV KCAC/CI principles PM and precursors of PM and ozone (potentially NO_x, SO_2, NH_3, VOCs, CO, combustion particulate emissions)			
CEMA (Oil Sands Area) Ozone Management Framework	Ozone Management Framework for the Regional Municipality of Wood Buffalo	Regional Municipality of Wood Buffalo 2006	Protect human health and vegetation from human-caused ground-level ozone	Ambient ozone concentrations, as per the provincial PM and ozone framework Precursors to ozone (NO_x, VOCs, CO	AENV, supported by EC, WBEA, AEUB, and contributing emitters	Monitoring of ambient ozone and precursors Trend analysis and modeling to predict possible future non-compliance	Consistent with provincial framework
CEMA (Oil Sands Area) Acid Deposition	Recommendations for the Acid Deposition Management Framework for the Oil Sands Region of North-Eastern Alberta	Regional Municipality of Wood Buffalo 2004	To manage acid deposition from industrial activity to maintain the chemical characteristics of soils and lakes to avoid adverse effects on ecosystems, plants, or animals in the management area	Deposition of acidifying substances (NO_x and SO_2) Management objectives, defined in terms of chemical change in soils and lakes, are not exceeded: No significant trend in monitored soil or lake chemistry Specified maximum model-predicted change within 15 and 30 years to selected chemical parameters of soils and lakes	AENV and/or regional stakeholders, including contributing emitters	Monitoring of chemical change related to acid deposition in soils or lakes Modeling to predict future change in soil or lake chemistry related to acid deposition	Regional stakeholders to develop a plan within 2 years to reduce, or prevent further increase in, deposition, with a regulatory backstop if stakeholders cannot reach agreement within 2 years

Framework	Document	Jurisdiction and Date Issued	Goal	Pollutants/ Emissions Managed	Implementation Agency	Compliance Assessment	Management Actions if Non-Compliance
EUB Flaring, Venting and Incinerating Requirements	Current Requirements: EUB Directive 060: Upstream Petroleum Industry Flaring, Incinerating, and Venting http://www.eub.ca/docs/documents/directives/Directive060.pdf	Alberta Original Guide 60 was issued in July 1999 and came into effect in January 2000. The companion Updates and Clarification was issued in February 2001. The new Directive was issued in November 2007.	Reduce the volume of natural gas that is flared, incinerated, and vented. Flaring, venting and incinerating must also be conducted in a manner that ensures public safety and protection of the environment.	Vented hydrocarbons, smoke and incomplete combustion emissions from flaring and incinerating, H_2S and SO_2.	Alberta Energy and Utilities Board (EUB)	Flared, vented and incinerated gas volumes must be reported to the EUB. EUB Statistical Series ST-60 provides annual summary and details of flared and vented gas, solution gas conservation and progress on reductions (http://www.eub.ca/docs/products/STs/st60b_current.pdf).	The Directive sets out equipment design and operational requirements for upstream oil and gas routine and non-routine (maintenance and emergency) flaring, venting (including fugitive emissions) and incinerating. The Directive addresses well test flaring/incinerating, routine solution gas disposal by flaring/incinerating/venting and flaring/venting/incinerating at production, pipeline and processing facilities.
Alberta Sulphur Recovery Guidelines	ID 2001-03: Sulphur Recovery Guidelines for the Province of Alberta http://www.eub.ca/docs/ils/ids/pdf/id2001-03.pdf	Alberta Issued August 29, 2001 and came into effect January 1, 2002	Reduce sulphur emissions from upstream oil and gas facilities, sour gas plants, refineries and upgraders.	Sulphur as SO_2 or H_2S. Sulphur from upstream oil and gas facilities, sour gas plants, refineries and upgraders.	Alberta Energy and Utilities Board and Alberta Environment (joint ID)	Sulphur balances for sulphur recovery gas plants are reported monthly to the EUB (S-30 reports). SO_2 emissions from sour gas plants are reported to AENV. Annual report on sour gas plant sulphur recovery and de-grandfathering	The Interim Directive (ID) sets out sulphur recovery requirements and defines how the requirements apply to sour gas plants, other upstream oil and gas facilities, refineries and upgraders. The ID sets out the process for eventual de-grandfathering of older sour gas plants, as well as requirements to

Framework	Document	Jurisdiction and Date Issued	Goal	Pollutants/ Emissions Managed	Implementation Agency	Compliance Assessment	Management Actions if Non-Compliance
						issued by EUB (http://www.eub.ca/docs/products/STs/ST101_2005.pdf).	address unnecessary proliferation of sour gas plants
Air Emissions Management in Alberta's Electricity Generation Sector	An Emissions Management Framework for the Alberta Electricity Sector Report to Stakeholders (available at http://casahome.org/uploads/Emissions_Mgmt_Framework.pdf). The new emission standards are laid out in the document entitled: Alberta Air Emission Standards for Electricity Generation and Alberta Air Emission Guidelines for Electricity Generation (available at http://www3.gov.ab.ca/env/air/Documents/2006_Power_Plant_Emission_Standards.pdf	Alberta Report released Nov. 2003 and adopted by provincial government in March 2004. Implementation has involved passing regulations related to emission trading and Hg control and publishing updated air emission control standards for coal and gas-fired electrical generation units.	To effectively manage air emissions from the Alberta Electricity Sector on a long-term basis through a framework that establishes processes for reviewing and updating air emission control requirements.	SO_2, NO_x, PM and Hg specifically but expected co-benefits from the management of these substances for other substances. (Note: the framework is significant in terms of managing acidifying emissions since approx. 21% of the province's SO_2 emissions and 14% of the province's NO_x emissions are from the electricity sector.)	Principally AENV	The framework is implemented through regulations and individual facility approvals under the *Alberta Environmental Protection and Enhancement Act*. AENV has a number tools it uses to ensure compliance - see: http://www3.gov.ab.ca/env/protenf/compliance/pubs/FactSheet_ComplianceTools.pdf The framework establishes a regular 5 year review of overall sector performance in terms of emission levels/ reductions to determine whether the expected level of reduction/ management is being achieved. There is a "hotspots" provision	If the overall sector emission reductions and trends that were projected as a result of the framework are not being realized there is a provision to review and revise the framework.

Framework	Document	Jurisdiction and Date Issued	Goal	Pollutants/ Emissions Managed	Implementation Agency	Compliance Assessment	Management Actions if Non-Compliance
						to address any air quality issues related to power plant emissions and AENV has developed a "hotspots protocol" for dealing with these issues.	
Alberta Ambient Air Quality Objectives (AAQOs)	Fact Sheet available at: http://www3.gov.ab.ca/env/air/OGS/objexisting.html	Alberta Individual objectives have own effective dates	AAQOs are established to define desired environmental quality that will protect public health and ecosystems. AENV ensures that emissions from human activities in the province will be minimized and that the province's air quality continues to be better than the AAQOs now and in the future	Fact sheet lists substances	AENV	AAQOs are compared to actual air quality measurements to report on the state of Alberta's environment, special ambient air quality surveys and current air quality through the Air Quality Index	Objectives are used to establish approval conditions and can be used to assess compliance and evaluate performance. Enforcement actions can be taken.